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**Breast and complementary feeding in Ethiopia: new national evidence from systematic review and meta-analyses of studies in the past 10 years**

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## Abstract

**Purpose:** The aim of this systematic review and meta-analysis was to provide a national estimate of breast and complementary feeding practices and its predictors in Ethiopia.

**Methods:** PubMed, SCOPUS, EMBASE, CINHALL, Web of Science and WHO Global Health Library electronic databases were searched for all available literature published until April 2018. Observational studies including cross-sectional, case-control and cohort studies were included. Newcastle-Ottawa Scale (NOS) was used to assess the quality of studies. Heterogeneity of studies was quantified using Cochran's  $Q \chi^2$  statistic and Higgins's method ( $I^2$ ). A meta-analysis using a weighted inverse variance method was performed. Subgroup analysis was carried out based on region and study area.

**Results:** In total, 70 studies that involved >55,000 women from nine regions and two chartered cities in Ethiopia were included. The pooled national prevalence for timely initiation of breastfeeding (TIBF), exclusive breastfeeding (EBF) and timely initiation of complementary feeding (TICF) was 66.5%, 60.1% and 62.5% respectively. Guidance and counselling on breastfeeding, vaginal delivery and health institution delivery significantly increased the odds of TIBF and EBF. In addition, TIBF significantly associated with high EBF practice. Maternal occupational status significantly associated with low EBF practice, but not TIBF.

**Conclusions:** Based on the WHO standard, the current breast and complementary feeding practice in Ethiopia is good and improving. Integrated intervention is still required for further improvement and minimizing the effect of occupational status.

**Keywords:** Breastfeeding, Complementary feeding, Meta-analysis, Infant Nutritional Physiological Phenomena, Ethiopia

## Introduction

The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) Innocenti Declaration urges developing a national breastfeeding strategy and establishing monitoring and control system [1]. In 2017, the global coverage of timely initiation of breastfeeding (TIBF), exclusive breastfeeding (EBF) and timely initiation of complementary feeding (TICF) was 44%, 40% and 64.5% respectively [2,3]. A meta-analysis of demographic and health surveys from 29 sub-Saharan African countries shows that the prevalence of TIBF ranges from 37.8% to 69.3%, EBF is 23.7% to 56.6%, predominant breastfeeding is 17.6% to 46.4% and bottle feeding is 8.17% to 30.1% [4]. Based on the WHO survey of the 129 nations, only 22 nations have achieved 70% TIBF and 23 countries have achieved at least 60% of EBF [2]. Generally, optimal breast and complementary feeding are high in low- and middle-income countries [2,3].

TIBF within 1 hour after birth and EBF until 6 months followed by appropriate complementary foods have various advantages for maternal, child and societal health [5]. Optimal breast and complementary feeding are also crucial for the achievement of three Sustainable Development Goals (SDG): improves nutrition (SDG-2), decreases child mortality and the risk of non-communicable diseases (SDG-3), and improves cognitive development and education (SDG-4) [2]. Despite these advantages, many women stop breastfeeding and switch to infant formula feeding too early. Suboptimal feeding increases the risk of morbidity and mortality up to fivefold [6]. Approximately 25 to 50% of infant mortality in developing countries occurs due to suboptimal feeding practice [7,8].

Globally, previous studies identified multiple predictors of suboptimal feeding including guidance and counselling, smoking, residence, place of delivery, maternal educational level, maternal occupational status, income, mother's age, mode of delivery, newborn's gender, health status of mother and newborn at delivery [9-11]. The same factors have been reported to contribute to sub-optimal breastfeeding in Sub-Saharan Africa [12].

Ethiopia is Africa's second most populated country located in the Horn of Africa. According to the 2015 projection, the total population was 90,078,000 [13]. Ethiopia is administratively divided into nine regional states (Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali, Tigray and SNNPR) and two chartered cities (Addis Ababa and Dire Dawa). Figure 1 shows regions and chartered cities of Ethiopia.

Fig. 1 Geographic map of Ethiopia that shows regions and chartered cities.

In Ethiopia, several studies have been conducted on breast and complementary feeding, and they identified multiple predictors. However, none of these studies provided a national estimate and the findings are inconsistent.

Since 2000, the Ethiopian Demographic and Health Survey has been conducted every 5 years and provided a national estimate on breast and complementary feeding; however, it does not provide evidence on the associated factors. So far, one meta-analysis [14] was done in Ethiopia aimed to study the prevalence of TIBF and its association with the place of residence and delivery. The present study has the following aims: (1) to provide a national pooled estimate on the prevalence of TIBF, EBF and TICF separately; (2) to conduct a comprehensive systematic review on various associated factors of TIBF, EBF and complementary feeding; (3) developing/proposing a multilevel theoretical model in the context of Ethiopian population; (4) to conduct meta-analysis on the association between TIBF and maternal occupational status, guidance and counselling on breastfeeding, place of delivery and mode of delivery; and (5) to conduct meta-analysis on the association between EBF and maternal occupational status, guidance and counselling on breastfeeding, place of delivery, mode of delivery and TIBF. We hypothesized (1) guidance and counselling on breastfeeding, health institution delivery and vaginal delivery increases TIBF and EBF; (2) TIBF increase EBF; and (3) Being government employed reduce TIBF and EBF.

## Methods

### Protocol registration and publication

The protocol has been registered in the International Prospective Register of Systematic Reviews (PROSPERO) ([http://www.crd.york.ac.uk/PROSPERO/display\\_record.asp?ID=CRD42017056768](http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42017056768)) and published [15].

### Databases searching

PubMed, SCOPUS, EMBASE, CINHAL, Web of Science and WHO Global Health Library databases were searched for all available literature. Additional studies were also identified from the reference lists of identified articles and gray literature. Search string was constructed for each database (Supplementary file 1).

### Inclusion and exclusion criteria

Studies that meet the following criteria were included: (1) observational studies including cross-sectional, case-control and cohort studies; (2) studies reported the prevalence and/or associated factor(s) of TIBF or EBF or TICF; (3) studies conducted in Ethiopia; and (4) studies that ascertained outcomes based on WHO [16] infant and young child feeding (IYCF) indicators definitions. The search was further limited to studies published in English from October 2000 to April 2018. Commentaries, anonymous reports, letters, protocols, systematic reviews, program evaluation reports, duplicate studies, editorials, qualitative studies, and abstracts without full-text were excluded. In addition, studies with infants who were preterm, low birth weight, in neonatal intensive care unit and mothers or infants with known medical problems such as HIV/AIDS were excluded.

### Study screening and selection

Firstly, all studies retrieved from all databases were exported to RefWorks version 2.0 web-based citation manager and, close and exact duplicates were deleted. Secondly, all independent studies were exported to Microsoft Excel spreadsheet. Thirdly, two independent reviewers' (TD and BS) screened the title and abstract of each study followed by agreement test using Cohen's kappa coefficient. The kappa coefficient was 0.76 with an asymptotic standard error of 0.05 indicating the agreement between the two reviewers' was 'good'. Finally, full-text review was performed and the following data were extracted: first name of author, year of publication, region, study area, study design, study population, number of respondents, data collection method, prevalence, and significantly associated factors ~~with its respective odds ratio (OR) and 95% confidence interval (CI).~~

## **Quality and validity of risk assessment**

Newcastle-Ottawa Scale (NOS) [17] was used to assess the quality of studies. The following items were included to evaluate studies: (1) selection, (2) comparability, and (3) the ascertainment of the outcome. NOS has a good inter-rater reliability and validity [18]. We ensured that the study population of all included studies was randomly chosen from the sampling frame and all NOS criteria satisfactorily fulfilled.

## **Statistical analysis**

A meta-analysis using a weighted inverse variance method was performed to calculate the pooled national prevalence rate of breast and complementary feeding and the odds ratio of associated factors. To adjust the effect of high or low prevalence studies on the pooled estimate, the arc-sine transformation was used [19]. Publication bias was checked through visual inspection of Funnel plot asymmetry and Egger's regression test [20]. Heterogeneity of studies was quantified using the significance level of Cochran's  $Q \chi^2$  statistic and Higgins's method where  $I^2$  statistic >80% (reference value) indicating substantial heterogeneity [15]. Given the limitations of these methods and lack of consensus on the exact cut-off value to confirm heterogeneity in different studies [21,22], however, homogeneity of studies rigorously checked in terms of study setting, study population, study design, data collection method, sampling technique and statistical analysis [23]. A separate forest plot was constructed for each meta-analysed variable. The data were entered using SPSS version 23 and meta-analysed using 'meta' and 'metafor' packages in R software version 3.4.2. Subgroup analysis was carried out based on region (Amhara region versus other regions) and study area (rural, urban, rural and urban).

## **Data synthesis and reporting**

Firstly, a meta-analysis of prevalence was done for TIBF, EBF and TICF separately. Secondly, all previously reported significantly associated factors were collected and categorized into four levels using the multilevel theoretical model adapted from previous systematic reviews [24,25]. Finally, a meta-analysis was done for selected (level 1 and level 2) associated factors; to increase the power, all studies that reported significant and non-significant association were included in the meta-analysis. Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2009 statement [26,27] and A MeaSurement Tool to Assess Systematic Reviews (AMSTAR 2)[28] were used to report this systematic review and meta-analysis.

## Results

### Search results

We obtained 169 articles from PubMed search, 24 articles from EMBASE, 200 articles from Web of Science, 85 articles from SCOPUS and 5 articles from others (CINHAL and WHO Global Health Library). Forty-nine additional articles were found through a manual search of cross-references. After removing duplicates and screening of titles and articles, 83 studies were selected for full-text review. Eleven primary studies on late initiation of breastfeeding, duration/cessation of exclusive breastfeeding, early initiation of complementary feeding, prelacteal feeding and breastfeeding measurements tools [29-39] and two project reviews [40,41] were excluded from the final analysis. These articles were published between the years 2007 and 2016. Seven studies were conducted in Amhara region [32-38], two studies in Southern Nations, Nationalities, and Peoples' Region (SNNPR) [30,31], one study in Oromia region [29] and one study in Amhara, Oromia, SNNPR and Tigray regions [38]. Two studies have used EDHS-based data[32,34], eight studies were conducted in urban and rural setting, 10 studies were interviewer administered and one study was prospective study [34]. Detailed explanations of excluded studies presented in Supplementary file 2. Finally, 70 articles published between years 2009 and 2018 were included and used for meta-analysis. The PRISMA flow diagram of literature screening and selection process is shown in Fig. 2.

**Fig. 2** PRISMA flow diagram of literature screening and selection process; “n” in each stage represents the total number of studies that fulfilled a particular criterion (Note: There are studies reported more than one outcome indicator)

### Timely initiation of breastfeeding (TIBF)

Among the 70 included studies, 45 studies reported the prevalence of TIBF with a total of 47,858 individuals. Seventeen studies conducted in Amhara region, nine in SNNPR, 7 studies in Oromia, and 9 studies in other regions, such as Tigray, Addis Ababa, Harari and Afar. Two studies [42,43] were nationally conducted and one study [44] was conducted in SNNPR, Oromia and Amhara regions. Regarding setting, 11 studies were conducted in a rural, 17 in urban and 17 in both urban and rural. Furthermore, the detailed characteristics of included studies presented in Tables 1.



The highest prevalence (93.3%, 95% CI 88.4 to 96.6%) was reported in Oromia region [70] and the lowest (39.6%, 95% CI 34.7 to 44.7%) was reported in SNNPR [76]. The national prevalence of TIBF was 66.5% (95% CI 62.1% to 70.8%) (Fig. 3).

**Fig. 3** Forest plot of the national prevalence of TIBF with sample size, 95% confidence interval, weight and test for heterogeneity. The horizontal line represents confidence interval, the large polygon represent a pooled estimate from a random effects model, the small polygon represents a pooled estimate from the fixed effects model. Each box and its size represent the weight of the sample size. The overall pooled estimate was presented in the last line (bold color)

The subgroup analysis based on study area showed that the pooled prevalence was 62.3% (95% CI 52.9 to 71.3%) in rural, 74.5% (95% CI 67.6 to 80.9%) urban and 60.7% (95% CI 55.2 to 66.1%) both rural and urban. The subgroup analysis based on region depicted that the prevalence was 68.2% (95% CI 59.9 to 76.0%) in Amhara region and 65.4% (95% CI 60.2 to 70.5%) in other regions. Subgroup analysis based on region was repeated after excluding two national studies [42,43] and one study [44] conducted in SNNPR, Oromia and Amhara region; the prevalence remained high in Amhara region.

Nineteen studies reported 18 factors that significantly associated with TIBF. Based on a model built by previous meta-analysis [24,25], these factors were categorized into four levels. The most commonly reported predictors were mothers' knowledge of TIBF, guidance and counselling on breastfeeding, place of delivery, mode of delivery and place of residence (table 2).

In order to estimate the pooled effect, a meta-analysis was carried out on the association between TIBF and occupational status (government employed versus unemployed), guidance and counselling on breastfeeding ('yes' versus 'no'), place of delivery (health institution versus home) and mode of delivery (vaginal versus cesarean section). The pooled odds ratio (OR) of TIBF for women who were government employed was 0.82 (95% CI 0.59 to 1.13,  $p = 0.22$ , Fig. 4) [42,51,58,60,61,66,77], counseled 1.96 (95% CI 1.18 to 3.26,  $p = 0.01$ , Supplementary Fig. 1) [56,58-61,68], delivered at health institution 1.76 (95% CI 1.15 to 2.71,  $p = 0.01$ , Supplementary Fig. 2) [42,51,56-59,61,62,64-66,68,77,78] and delivered vaginally 3.35 (95% CI 1.94 to 5.79,  $p < .0001$ , Supplementary Fig. 3) [42,51,57-59,61,66-68].

**Fig. 4** Forest plot of the unadjusted odds ratios with corresponding 95% CIs of studies on the association of maternal occupational status and TIBF. The horizontal line represents the confidence interval, the box and its size in the

middle of the horizontal line represent the weight of sample size. The polygon represents the pooled odds ratio. The reference category is 'Nonemployed'. TIBF=timely initiation of breastfeeding; LIBF=late initiation of breastfeeding; REM=random effects model

#### **Exclusive breastfeeding (EBF)**

Out of 70 included studies, 44 studies reported the prevalence of EBF with a total of 25,816 participants. Seventeen studies conducted in Amhara region, 12 in SNNPR, five studies in Oromia and eight studies in other regions, such as Tigray, Addis Ababa, Harari and Afar. Two studies were nationally conducted [43,45]. Based on setting, 10 studies were conducted in a rural, 17 in urban and 17 in both rural and urban. Detailed characteristics of included studies presented in Tables 3.

The highest prevalence (87.8%, 95% CI 79.2 to 93.7%) was reported in Oromia region [72] and lowest (29.3%, 95% CI 25.8 to 33.0%) prevalence in Addis Ababa [75]. The national prevalence of EBF was 60.1% (95% CI 55.5% to 64.6%) (Fig. 5).

**Fig. 5** Forest plot of the national prevalence of EBF with sample size, 95% confidence interval, weight and test for heterogeneity. The horizontal line represents confidence interval, the large polygon represent a pooled estimate from a random effects model, the small polygon represents a pooled estimate from the fixed effects model. Each box and its size represent the weight of the sample size. The overall pooled estimate was presented in the last line (bold color)

The subgroup analysis based on study area showed that the prevalence was 68.8% (95% CI 60.8 to 76.3%) in rural, 54.9% (95% CI 47.5 to 62.3%) urban and 60.0% (95% CI 52.3 to 67.3%) both rural and urban area.

Subgroup analysis based on region depicted that the prevalence was 58.6% (95% CI 51.3 to 65.8%) in Amhara region and 61% (95% CI 54.8 to 67.0) in other regions. Subgroup analysis based on region was repeated after excluding two national studies [43,45]; the prevalence remained low in Amhara region.

Thirty-two studies reported 26 factors that significantly associated with EBF. Similar to TIBF, these factors were categorized into four levels. The most commonly reported predictors were maternal occupational status, mothers' knowledge on exclusive breastfeeding, guidance and counselling on breastfeeding, timely initiation of breastfeeding, antenatal care follow-up, household income and age of newborn (table 4).

Meta-analysis was carried out on the association between EBF and mode of delivery (vaginal versus cesarean section), occupational status (government employed versus unemployed), guidance and counselling on

breastfeeding ('yes' versus 'no'), place of delivery (health institution versus home) and TIBF (within one hour versus after 1 hour) to estimate the pooled effect on EBF. The pooled odds ratio (OR) of EBF for women who delivered vaginally was 1.81 (95% CI 1.19 to 2.77,  $p=0.006$ , Fig. 6) [50,51,73,75,81,82,85,88,92,96], government employed 0.60 (95% CI 0.40 to 0.91,  $p=0.02$ , Supplementary Fig. 4) [45,51,73,80,81,85-88,92,93,96,100], counselled 2.29 (95% CI 1.56 to 3.34,  $p<0.001$ , Supplementary Fig. 5) [68,73,75,81,82,85-88,90,99], delivered at health institution 2.33 (95% CI 1.82 to 2.98,  $p<0.001$ , Supplementary Fig. 6) [48,68,73,75,80-82,85,87-92,95-99] and initiated breastfeeding within one hour 2.02 (95% CI 1.46 to 2.79,  $p<0.001$ , Supplementary Fig. 7) [47,51,81,83,84,89-91,97-99].

**Fig. 6** Forest plot of the unadjusted odds ratios with corresponding 95% CIs of studies on the association of mode of delivery and EBF. The horizontal line represents the confidence interval, the box and its size in the middle of the horizontal line represent the weight of sample size. The polygon represents the pooled odds ratio. The reference category is 'CS'. EBF=exclusive breastfeeding; NEBF=non-exclusive breastfeeding; REM=random effects model; CS=Caesarean section

#### Complementary feeding

From 70 selected studies, 21 studies reported the prevalence of timely initiation of complementary feeding (TICF) with 8,644 individuals. Six studies conducted in Amhara region, five in SNNPR, three studies in Oromia, three studies in Tigray and three studies in Harari and Benishangul-Gumuz. One study [43] was nationally conducted. Based on place of residence, five studies were conducted in a rural, eight in urban and eight in both rural and urban. Detailed characteristics of included studies presented in Tables 5.

The highest prevalence (86.2%, 95% CI 82.5 to 89.5%) was reported in Amhara region [111] and lowest (34.3%, 95% CI 30.3 to 38.4) in SNNPR [76]. The national prevalence of TICF was 62.5% (95% CI 56.6% to 68.2%) (Fig. 7).

**Fig. 7** Forest plot of the national prevalence of TICF with sample size, 95% confidence interval, weight and test for heterogeneity. The horizontal line represents confidence interval, the large polygon represent a pooled estimate from a random effects model, the small polygon represents a pooled estimate ~~form~~from the fixed effects model. Each box and its size represent the weight of the sample size. The overall pooled estimate was presented in the last line (bold color)

The subgroup analysis based on study area showed that the prevalence was 54.8% (95% CI 36.5 to 72.5%) in rural, 64.9% (95% CI 57.6 to 71.9%) urban and 63.8% (95% CI 54.3 to 72.8%) both rural and urban. Subgroup analysis based on region depicted that the prevalence was 67.8% (95% CI 57.2 to 77.6%) in Amhara region and 60.2% (95% CI 53.0 to 67.1%) in other regions. Subgroup analysis based on region was repeated after excluding one national study [43]; the prevalence remained high in Amhara region.

Fourteen studies reported 17 significantly associated factors of complementary feeding and categorized into four levels using the aforementioned method (table 6).

### Summary of prevalence estimates

Table 7 shows the summary of number of people and studies in each region/city and prevalence estimates (i.e. national, regional and areal) of each infant and young child feeding indicator. Nearly half of the studies on each infant and young child feeding indicator conducted in Amhara region. The prevalence of TIBF, EBF and TICF was 66.5%, 60.1% and 62.5 respectively.

### Quality check, heterogeneity and publication bias

All the included studies meet a reasonably acceptable quality level. Notably, high  $I^2$  value and a significant Cochran's  $Q \chi^2$  statistical test was observed in the meta-analysis of prevalence estimate and odds ratio respectively. Firstly, included studies were rigorously checked for their study design, data collection technique, outcome definition, statistical analysis, study setting, publication year and study population [23]. Secondly, the prevalence was transformed using the arcsine square root to adjust the influence of studies that reported high or low prevalence estimate. Thirdly, stratification analysis was done based on quartile of the total sample size of included studies, study area and region. However, there was no major change in the  $I^2$  value. Given the absence of a single  $I^2$  cut-off value for deciding on heterogeneity in different studies [21,22] and lack of changes after the above-mentioned measures, a meta-analysis was done based on the reviewer's judgment. Finally, the interpretation was done based on the random-effects model.

Regarding meta-analysis of the odds ratio, based on  $I^2$  value, homogeneity of studies was reasonably good. Given the limitation of Cochran's  $Q \chi^2$  statistical test when the number of studies is small [112] and lack of substantial heterogeneity based on reviewers' qualitative evaluation, a meta-analysis was done as well. Following a

visual inspection of a funnel plot and Egger's statistical test for asymmetry, significant publication bias was not observed among included studies.

#### **Time-trend analysis**

The prevalence of TIBF from 2011 to 2018 was steady. The prevalence of both EBF and complementary feeding have been increasing substantially since 2009 (Fig. 8).

**Fig. 8** Time-trend analysis of timely initiation of breastfeeding (A), exclusive breastfeeding (B) and timely initiation of complementary feeding (3). Red mark indicates the individual studies. The blue line represents the average point estimate (middle) and their 95% confidence band (lower and upper)

## Discussion

This is the most comprehensive systematic review and meta-analysis to date and the first of its kind that involving >55,000 participants from Ethiopia. The national prevalence of timely initiation of breastfeeding (TIBF), exclusive breastfeeding (EBF) and timely initiation of complementary feeding (TICF) was 66.5%, 60.1% and 62.5% respectively. Guidance and counselling on breastfeeding, mode of delivery and place of delivery significantly associated with high odds of TIBF and EBF. TIBF significantly associated with low odds of EBF. Maternal occupational status (being employed) significantly associated with low odds of EBF, but not TIBF.

According to the World Health Organization (WHO) standard [113], the nationwide practice of TIBF and EBF in Ethiopia is 'good' (i.e., 50 to 89%) whereas TICF is 'fair' (i.e., 60 to 79%). This is novel given only 22 out of 129 nations achieved 70% in TIBF and 23 out of 129 nations achieved 60% in EBF [2]. The prevalence rate of TIBF in Ethiopia is equivalent with the recent estimate in Zambia, Sudan, Iran, United Kingdom, Uzbekistan, Lesotho, Madagascar and Ukraine [114,115]. The prevalence of EBF is equivalent with Uganda, Zambia, Bolivia, Peru and Cambodia [115]. On the other hand, the current finding is 2 to 3 times higher compared to the recent estimate of WHO European Region member countries where the rate of TIBF and EBF was 43% and 23% respectively [116]. This finding also higher than the prevalence of TIBF (34.3%) and EBF (20.5%) in Middle East countries (Saudi Arabia, Iran, Egypt, Turkey, Kuwait, the United Arab Emirates, Qatar, Lebanon, and Syria) [117]. The prevalence of TICF in Ethiopia was the same as the recent global estimate [3], but on the other hand, it was lower than the prevalence rate in five European Union countries (Germany, Belgium, Poland, Italy and Spain) [118] and two South Asian countries (Bangladesh and Nepal) [119] where 87% and approximately 71% of infants receiving complementary feeding by 6 to 8 months.

In this study, health institution delivery, counselling on breastfeeding and vaginal delivery significantly increased the odds of TIBF and EBF. This is in agreement with an international study from 57 nations [120], WHO survey [121], systematic review and meta-analysis [122] and a prospective cohort study in North America [123]. Additionally, maternal employment status and TIBF significantly associated with EBF as concluded by previous studies in Africa, Middle East and Europe [124-126]. On the other hand, recent studies in Ireland and UK [114], and Canada [127] reveals that home delivery significantly increased the odds of TIBF and EBF. Another study in Central America showed that mode of delivery does not affect TIBF and EBF [128]. This inconsistency may be due to the difference in socio-economic status and health care services. In our study, maternal employment status not

significantly reduced TIBF. This non-significant result may be due to the small number of studies included in the meta-analysis.

All previously identified predictors of breast and complementary feeding were carefully reviewed and a hierarchical theoretical model was developed. The model would be helpful for future researchers to develop a priori hypothesis. We noticed all the included studies have no prior hypothesis about a specific variable and researchers just included all studied variables into a model and checked the association with the outcome. This may create overestimation of the model and may bias the interpretation of results. In addition, primary health care workers may have faced difficulty on the prioritization of factors for intervention as evidenced by the low coverage of breast and complementary feeding although the government implementing several programs, such as Baby-friendly Hospital Initiative programme (BF-HIP) and health extension package. Thus, the proposed model can also be used as a framework for prioritization of community problems. Moreover, Ethiopia is not included in the current WHO evaluation surveys [2,121] which may be due to the unavailability of updated data; therefore, this finding may be useful for next WHO international surveys.

This study has limitations. First, almost all included studies are cross-sectional which may influence the strength of evidence; however, this can be compensated by a large sample of selected studies which could increase the power of our analyses. Second, high heterogeneity was detected based on the conventional method; therefore, readers should interpret the result cautiously. Third, the risk of reporting bias may be added due to exclusion of studies with preterm newborn or known maternal diseases. Fourth, even though studies were conducted in all regions and cities, some regions/cities may be over- or under-represented. Finally, the pooled effect size was not adjusted for the size of the sampling frame.

## **Conclusions and future directions**

TIBF, EBF and TICF practices were promising and improving compared to the previous years as revealed in the time-trend analysis. Occupational status (being government employed) was a barrier to optimal breastfeeding although not significant for TIBF. Counselling on breastfeeding, health institution delivery and vaginal delivery were facilitators of TIBF and EBF. Moreover, TIBF was a facilitator for EBF. Based on the time-trend analysis, the coverage has been increasing from year-to-year.

To further increase the coverage and minimize barriers of optimal IYCF, the government should implement the global breastfeeding collective calls [2] including increasing fund, endorse workplace breastfeeding policies and

fulfill necessary facilities, improve access to skilled breastfeeding counselling and encourage community networks. Further meta-analysis based on (inter)national studies on other IYCF indicators and associated factors other than currently studied is required to conclude whether they are facilitator or inhibitor of optimal breast and complementary feeding. Moreover, case-control, cohort, and randomized control trial studies on breast and complementary feeding in Ethiopia would be relevant which can provide a strong evidence. So far unlike institutional-, demographic- and health-related factors, behavioural factors are not studied very well yet. Therefore, further studies shall give due emphasis to those factors.

**Contributorship statement**

Tesfa Dejenie conceived and designed the study. Tesfa Dejenie and Balewgizie Sileshi screening articles, extracted the data and carried out the statistical analysis. All authors contributed for writing and revising the manuscript. All the authors read the manuscript and have given the final approval for publication.

**Data sharing statement**

All the data used in this systematic review and meta-analysis were included in the main documents and as a supplementary file.

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**Conflict of interest**

The authors declare that they have no conflict of interest.



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768 **Table 1: Characteristics of included studies that reported the prevalence and/or least adjusted associated factors of TIBF.**

<b>First author and year of publication</b>	<b>Region</b>	<b>Place</b>	<b>Study area</b>	<b>Study design</b>	<b>Study population</b>	<b>Sample size/Participated</b>	<b>Data collection technique</b>	<b>Prevalence</b>	<b>Associated factors (least adjusted)</b>
Beyene et al 2017[56]	SNNPR, Southern Ethiopia	Urban and Rural	Dale Woreda	Cross-sectional study	Mothers with children < 24 months	634/634	Interviewer-administered	83.7%	Living in rented house
Liben and Yesuf 2016[57]	Afar, Northeastern Ethiopia	Urban and Rural	Amibara district	Cross-sectional study	Mothers of children aged < 24 months	407/403	Interviewer-administered	39.6 %	Urban residence Attended formal education Cesarean section delivery Birth order
Derso et al 2017[46]	Amhara, Northwest Ethiopia	Urban and Rural	Dabat district	Cross-sectional study (EDHS-based)	Mothers with children < five years of age	6,761/6,761	Interviewer-administered	43.9%	Urban residence Antenatal care No prelacteal feeding
Setegn et al 2011[58]	Oromia, South Eastern Ethiopia	Urban and Rural	Goba district	Cross-sectional study	Mothers with children < 12 months	668/608	Interviewer-administered	52.4%	Urban residence Postnatal counseling
Tewabe 2016[59]	Amhara, Northeast Ethiopia	Urban	Motta town	Cross-sectional study	Mothers with infant < six months	423/405	Interviewer-administered	78.8 %	Health institution delivery Vaginal delivery No prelacteal feeding
Hailemariam et al 2015[60]	Oromia, West Ethiopia	Rural	East Wollega zone	Cross-sectional study	Mothers with children < 24 months	594/593	Interviewer-administered	83.1 %	Being a housewife Colostrum feeding No access to mass media No breastfeeding counseling Prelacteal feeding
Tilahun et al 2016[61]	Amhara, Northeast Ethiopia	Urban	Debre Berhan town	Cross-sectional study	Mothers with children < six months	416/409	Interviewer-administered	62.6 %	High monthly income Extended family No breastfeeding counseling Cesarean section delivery Traditional birth attendant No colostrum feeding
Lakew et al 2015[42]	National	Urban and Rural	National	Cross-sectional study (EDHS-based)	Mothers children < 5 years	11,654/11,654	Interviewer-administered	52 %	Rural residence High educational status Cesarean section delivery Maternal employment Sex of newborn Aware of community

									conversation program
Bimerew et al 2016[62]	Amhara, North West Ethiopia	Rural	Dembecha district	Cross-sectional study	Mothers with children < 2 years	739/739	Interviewer-administered	73.1 %	Antenatal care Access to mass media Traditional birth attendant
Tamiru et al 2012[63]	Oromia, Southwest Ethiopia	Rural	Jimma Arjo Woreda	Cross-sectional study	Mothers with children 0 to 6 months	384/382	Interviewer-administered	62.6%	Painful breastfeeding experiences
Adugna et al 2014[64]	SNNPR, Southern Ethiopia	Rural	Arba Minch Zuria	Cross-sectional study	Women with children < two years	384/383	Interviewer-administered	57.2%	Breastfeeding knowledge Health education
Tamiru et al 2015[65]	SNNPR, Southern Ethiopia	Rural	Arba Minch Zuria Woreda	Cross-sectional study	Mothers with < two years	384/384	Interviewer-administered	57%	Health education
Horii et al 2011[44]	SNNPR, Oromia and Amhara	Urban and Rural	SNNPR, Oromia and Amhara	Survey	Mothers with children 0 to 11 months	2,084/2,072	Interviewer-administered	41.6%	Received iron–folate supplements
Alemayehu et al 2014[66]	Tigray, Northern Ethiopia	Urban	Axum town	Cross-sectional study	Mothers with children 6 to 12 months	418/418	Interviewer-administered	41.6%	Sex of newborn Colostrum discarding
Berhe et al 2013[51]	Tigray, Northern Ethiopia	Urban	Mekelle town	Cross-sectional study	Mothers of children < two years	361/361	Interviewer-administered	77.9%	Home delivery Vaginal delivery Health professional birth attendant
Seid 2014[67]	Amhara, Northwest Ethiopia	Urban	Bahir Dar City,	Cross-sectional study	Mothers of children < two years	819/819	Interviewer-administered	87.0%	Vaginal delivery Breastfeeding knowledge
Gultie and Sebsibie 2016[68]	Amhara, Northeastern Ethiopia	Urban	Debre Berhan town	Cross-sectional study	Mothers with children < 2 years	548/548	Interviewer-administered	82.5%	No breastfeeding counseling Home delivery
Regassa 2014[69]	SNNPR, Southern Ethiopia	Urban and Rural	Sidama zone	Cross-sectional study	Mothers with children 0 and 6 months	1,100/1,094	Interviewer-administered	80.1%	---
Wolde et al 2014[70]	Oromia, Western Ethiopia	Urban	Nekemte town	Cross-sectional study	Mothers children < two years	182/174	Interviewer-administered	88.5%	---
Disha et al 2012[43]	National	Urban and Rural	All regions	Cross-sectional study (EDHS	Mothers with children < two years	244/244	Interviewer-administered	60.7%	---

				based)					
Woldemichael et al 2016[71]	Oromia, Central Ethiopia	Urban and Rural	Tiyo Woreda	Cross-sectional study	Mothers with children < one year	386/373	Interviewer-administered	67.3%	---
Wubante 2017[55]	Amhara, Northwest Ethiopia	Urban and Rural	Dabat District	Case-control study	Mothers with children < one year	400/400	Interviewer-administered	59%	---
Yonas et al 2015[72]	Oromia, Southwest Ethiopia	Urban and Rural	Shashemene Woreda	Case-control study	Mothers with < two years	423/417	Interviewer-administered	58%	---
Arage et al 2016[73]	Amhara, Northwest Ethiopia	Urban	Debre Tabor Town	Cross-sectional study	Mothers with children < 6 months	470/453	interviewer administered	78.6%	---
Bayissa et al 2015[74]	Oromia, West Ethiopia	Urban and Rural	Ambo woreda	Cross-sectional study	Mothers with children < 2 years	403/371	Interviewer-administered	71.2%	---
Minas et al 2016[54]	Addis Ababa, Central Ethiopia	Urban	Addis Ababa	Prospective study	Primiparous women, and at the third trimester of pregnancy	233/233	Interviewer-administered	64.3%	---
Shiferaw et al 2015[75]	Addis Ababa, Central Ethiopia	Urban	Addis Ababa	Cross-sectional study	Mothers who attended a public health center for their children's measles vaccination at nine months of age	660/648	Interviewer-administered	29.3 %	---
Yohannes et al 2018 [76]	SNNPR, Southwest Ethiopia	Rural	Soro district	Cross-sectional study	Mothers with children 6-23 months	543/543	Interviewer-administered	55.4%	---
Ekubay et al 2018[77]	Addis, Central Ethiopia	Urban	Addis Ababa	Cross-sectional study	Mothers with children ≤ 6 months	597/583	Interviewer-administered	58.3%	Parity Antenatal care
Tariku et al 2017[78]	Amhara, Northwest Ethiopia	Urban and rural	Dabat District	Cross-sectional study (EDHS	Mothers with children 6–24 months	822/822	Interviewer-administered	53.3%	Health institution delivery Knowledge of infant and young child feeding

				based)					Husband educational status
Ersino et al 2016a[79]	SNNPR, Southern Ethiopia	Rural	Halaba	Cross- sectional study	Mothers with children < 2 years	268/268	Interviewer administered	62.7%	---
Ersino et al 2016b[79]	SNNPR, Southern Ethiopia	Rural	Zeway	Cross- sectional study	Mothers with children < 2 years	90/90	Interviewer administered	92.3%	---
Chekol et al; 2017[80]	Amhara, Northwest Ethiopia	Urban	Gondar town	Comparative cross- sectional study	Employed and unemployed mothers with children 7–12 months	649/649	Interviewer- administered	68%	---

769 EDHS = Ethiopian Demographic Health Survey; SNNPR = Southern Nations, Nationalities, and Peoples' Region

770 **Table 2: Predictors of TIBF and hierarchical theoretical model.**

S.No.	Factors
<b>Level 1 (Model 1): Proximal factors</b>	
1.	Mothers' occupational status [42,60]
2.	Mothers' knowledge about timely initiation of breastfeeding [42,60,62,64,65,67,78]
3.	Guidance and counselling on breastfeeding [58,60,61,68]
<b>Level 2 (Model 2): Proximal intermediate factors</b>	
1.	Place of delivery [51,59,68,78]
2.	Mode of delivery [42,51,57,59,61,67]
3.	Birth attendant [51,61,62]
4.	Sex of newborn [42,66]
<b>Level 3 (Model 3): Distal intermediate factors</b>	
1.	Antenatal visit [46,62,77]
2.	Prelacteal feeding [46,59,60]
3.	Colostrum feeding [60,61,66]
<b>Level 4 (Model 4): Distal factors</b>	
1.	Paternal educational status [42,57,78]
2.	Household income [56,61]
3.	Family size [61]
4.	Breastfeeding experience [63]
5.	Place of residence [42,46,57,58]
6.	Birth order [57]
7.	Received iron–folate supplements [44]
8.	Parity [77]

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774 **Table 3: Characteristics of included studies that reported the prevalence and/or least adjusted associated factors of EBF.**

First author and year of publication	Region	Place	Study area	Study design	Study population	Sample size/Participated	Data collection technique	Prevalence	Associated factors (least adjusted)
Setegn et al 2012[81]	Oromia, South East Ethiopia	Urban and Rural	Bale Zone, Goba district	Cross-sectional study	Mothers with children < 6 months	668/608	Interviewer-administered (24hrs recall method)	71.3%	Unemployment Age of infants of less than two months
Seid et al 2013[82]	Amhara, Northwest Ethiopia	Urban	Bahir Dar city	Cross-sectional study	Mothers gave birth in the last 12 months	819/819	Interviewer-administered (Since birth dietary recall method)	50.3%	Age of infant < 3 months Being a housewife Prenatal breastfeeding plan Health institution delivery Vaginal delivery Infant feeding counseling/advice
Dachew et al 2014[50]	Amhara, Northwest Ethiopia	Urban and rural	North Gondar Zone	Cross-sectional study	Nurses and midwives with children 6 to 20 months	178/178	Self-administered questionnaire	35.9%	Older women Rural residence Being midwife Vaginal delivery Multiparity Resumption of work after 3 months
Liben et al 2016[83]	Afar, Northeast Ethiopia	Urban	Dubti town	Cross-sectional study	Mothers with children < 6 months	346/333	Interviewer-administered (24-hrs recall method)	81.1%	Initiation of breastfeeding within one hour Age of infants < 2 months Being a housewife Counseling
Lenja et al 2016[84]	SNNPR, Southern Ethiopia	Rural	Offa district	Cross-sectional study	Mothers with children < 6 months	403/396	Interviewer-administered (24-hrs recall method)	78.0%	Initiation of breastfeeding within one hour Attending formal education Awareness of the benefits of exclusive breastfeeding Knowledge of colostrum feeding
Hunegnaw et al 2017[85]	Amhara, Northwest Ethiopia	Rural	Gozamin district	Cross-sectional study	Mothers with children 6 to 12 months	506/478	Interviewer-administered	74.1%	Government employment No breastfeeding counseling Health institution delivery
Tariku et al	Amhara,	Urban	Dabat	Cross-	Mothers with	5,227/5,227	Interviewer-	54.5%	Higher mothers' education

2017[47]	Northwest Ethiopia	and rural	District	sectional study (EDHS based)	children < 59 months		administered		Age (20±35 years) Urban residence Antenatal care Initiation of breastfeeding within one-hour High household income Withholding prelacteal feeding
Mekuria et al 2015[86]	Amhara, Northwest Ethiopia	Urban	Debre Markos	Cross-sectional study	Mothers with children < six months	423/413	Interviewer-administered (Seven-day self-recall method)	60.8%,	Unemployment Breastfeeding counseling No prelacteal feeding Knowledge of breastfeeding
Asfaw et al 2015[87]	Amhara, Central Ethiopia	Urban and rural	Debre Berhan District	Cross-sectional study	Mothers with children < 12 months	634/634	Interviewer-administered	68.6 %	Rural residence Mothers aged 25 to 35 years No infant feeding Counseling Employment Home delivery High educational status
Tewabe et al 2017[88]	Amhara, Northeast Ethiopia	Urban	Motta town, East Gojjam zone	Cross-sectional study	Mothers with children < six months	423/405	Interviewer-administered (24-hour infant diet recall method)	50.1%	Infants age 0-1 month Unemployment Low income Breastfeeding counseling Colostrum feeding No prelacteal feeding Husband support
Gizaw et al 2017[89]	Afar, Northeast Ethiopia	Rural	Hadaleala district	Cross-sectional study	Mothers with children between 6 and 24 months	258/254	Interviewer-administered ( 6 months recalling method)	74%	Mothers aged > 35 years Breastfeeding initiation within one hour Rural to urban migration
Sonko et al 2015[90]	SNNPR, Southern Ethiopia	Rural	Halaba special woreda	Cross-sectional study	Mothers with children < six months	422/420	Interviewer-administered	70.5 %	Antenatal care Postnatal care Initiation of breastfeeding within one hour Attending formal education Breastfeeding counseling Awareness of exclusive breastfeeding High monthly income (≥500ETB) Being



									housewife
Alemayehu et al 2009[45]	National	Urban and rural	National	Cross-sectional study (EDHS based)	Mothers with children < six months	14,500/1,142	Interviewer administered (24-hrs recall method)	49.0%,	Being not married High household income Child age < three months
Tamiru et al 2015[65]	SNNPR, Southern Ethiopia	Rural	Arba Minch Zuria Woreda	Cross-sectional study	Mothers with children < two years	384/384	Interviewer-administered	69%	Access to mass media Antenatal care Breastfeeding education Knowledge of exclusive breastfeeding
Tadesse et al 2016[91]	SNNPR, Southern Ethiopia	Rural	Sororo District	Cross-sectional study	Mothers with children < 5 months	602/579	Interviewer-administered ( 24-hrs recall method)	50.6%	Unmarried Initiation of breastfeeding after one hour No antenatal care No postnatal care
Tamiru et al 2012[63]	Oromia, Southwest Ethiopia	Rural	Jimma Arjo Woreda	Cross-sectional study	Mothers with children < 6 months	384/382	Interviewer-administered	47.9%	Ownership of radio Colostrum discarding
Asemahagn 2016[92]	Amhara, Northwest Ethiopia	Urban	Azezo district	Cross-sectional study	Women with children < 6 months	346/332	Interviewer-administered (24-hrs recall method)	79 %	Mothers aged ≥ 30 years Unemployment Low maternal income Health institution delivery Antenatal care Postnatal care No prelacteal feeding
Alemayehu et al 2014[93]	Tigray, Northern Ethiopia	Urban	Axum town	Cross-sectional study	Mothers with children between 6-12 months	418/418	Interviewer-administered	40.9%	No colostrum feeding
Berhe et al 2013[51]	Tigray, Northern Ethiopia	Urban	Mekelle town	Cross-sectional study	Mothers with children < 24 months	361/361	Interviewer-administered	60.8%	Unemployment Child age (<1 months)
Gultie and Sebsibie 2016[68]	Amhara, Northeastern Ethiopia	Urban	Debre Berhan town	Cross-sectional study	Mothers with children < 23 months	548/548	Interviewer-administered	50.2%	No breastfeeding counseling
Regassa 2014[69]	SNNPR, Southern Ethiopia	Urban and rural	Sidama zone	Cross-sectional study	Mothers with children between 0 and 6 months old	1100/1094	Interviewer-administered	56.0%	---

Biks et al 2015[48]	Amhara, Northwest Ethiopia	Urban and rural	Dabat district	Nested case-control study (EDHS based)	All pregnant women in the second/third trimester	1,769/1,769	Interviewer-administered	30.7 %	Private job Housewife Antenatal care Health institution delivery
Fenta et al 2017[94]	SNNPR, Southwest Ethiopia	Urban and rural	Gurage zone	Cross-sectional study	Mothers with children < 6 months	422/410	Interviewer-administered (Seven repeated 24 h recall method)	53.2%	---
Wubante 2017[55]	Amhara, Northwest Ethiopia	Urban and rural	Dabat District	Case-control study	Mothers with children < one year	400/400	Interviewer-administered	85.5%	---
Yonas et al 2015[72]	Oromia, Southwest Ethiopia	Urban and rural	Shashemene Woreda	Cross-sectional study	Mothers with children < 24 months	423/417	Interviewer-administered (24-hrs recall method)	87.8%	---
Abera 2012[95]	Harari, Eastern Ethiopia	Urban	Harar town	Cross-sectional study	Mothers with children < two years	604/583	Interviewer-administered	51.8%	High monthly income Health institution delivery
Arage et al 2016[73]	Amhara, Northwest Ethiopia	Urban	Debre Tabor Town	Cross-sectional study	Mothers with children < six months	470/453	Interviewer-administered (24-hrs recall method)	70.8%	Child age (2-3 months) Health institution delivery Housewife Infant feeding counseling Colostrum feeding
Adugna et al 2017[96]	SNNPR, Southern Ethiopia	Urban	Hawassa city	Cross-sectional study	Mothers with children < 6 months	541/529	Interviewer-administered (24-hrs recall method)	60.9%	Infant age Married Housewife Vaginal delivery Health institution delivery No breast complication
Bayissa et al 2015[74]	Oromia, West Ethiopia	Urban and rural	Ambo woreda	Cross-sectional study	Mothers with children < 2 years	403/371	Interviewer-administered	82.2%	---
Egata et al 2013[49]	Oromia, Easter Ethiopia	Urban and rural	Kersa district	Cross-sectional study (EDHS based)	Mothers with children < two years	881/860	Interviewer-administered	71.4%	Not married No access to health institution Lack of knowledge about

									infant and young child feeding practices
Minas et al 2016[54]	Addis Ababa, Central Ethiopia	Urban	Addis Ababa	Prospective study	Primiparous women during third trimester of pregnancy	233/233	interviewer administered	34.3%	Breastfeeding self-efficacy Breastfeeding outcome expectancy
Shiferaw et al 2015[75]	Addis Ababa, Central Ethiopia	Urban	Addis Ababa	Cross-sectional study	Mothers who attended a public health center for their children's measles vaccination at nine months of age	660/648	Interviewer-administered	29.3 %	Monthly income Breastfeeding counseling Mode of delivery
Ersino et al 2016a[79]	SNNPR, Southern Ethiopia	Rural	Halaba	Cross-sectional study	Mothers with children < 2 years	87/87	Interviewer administered	86.2%	---
Ersino et al 2016b[79]	SNNPR, Southern Ethiopia	Rural	Zeway	Cross-sectional study	Mothers with children < 2 years	15/15	Interviewer administered	93.3%	---
Taddele et.al. 2014[97]	Amhara, North west Ethiopia	Urban and Semi urban	Injibara Town	Comparative cross-sectional study	Mothers with children $\leq 1$ year	524/473	Interviewer-administered	65%	Husband support Timely initiation of breastfeeding Health education Non-professional delivery attendant Maternal age Health institution delivery
Echamo. 2012[98]	SNNPR, Southern Ethiopia	Urban	Arbaminch town	Cross-sectional study	Mothers with children 6 to 12 months	768/768	Interviewer-administered	46.5%	Lack of knowledge Home delivery Antenatal care Timely initiation of breastfeeding Colostrum discarding
Teka et al. 2015[99]	Tigray, Northern Ethiopia	Urban and rural	Enderta Woreda	Cross-sectional study	Mothers with children < 24 months	541/530	Interviewer-administered	70%	Maternal age Child age Postnatal care
Sefene et al. 2013[100]	Amhara, Northeast Ethiopia	Urban and	Bahir Dar city	Cross-sectional	Mothers with children < 6	170/159	Interviewer-administered	49.1%	Maternal educational status Family size

		rural		study	months				Sex of child Postnatal care Parity
Chekol et al; 2017[80]	Amhara, Northwest Ethiopia	Urban	Gondar town	Comparative cross- sectional study	Employed and unemployed mothers with children 7–12 months	649/649	Interviewer- administered	34.8%	Lack of knowledge Unemployment Poor attitude towards breastfeeding

775 EDHS = Ethiopian Demographic Health Survey; SNNPR = Southern Nations, Nationalities, and Peoples' Region

776 **Table 4: Predictors of EBF and hierarchical theoretical model.**

S.No.	Factors
<b>Level 1 (Model 1): Proximal factors</b>	
1.	Mothers' occupational status [48,50,51,73,80-83,85-88,90,92,96]
2.	Mothers' knowledge about exclusive breastfeeding [49,63,65,80,84,86,90,98]
3.	Guidance and counselling on exclusive breastfeeding [65,68,73,75,82,83,85-88,90]
4.	Access to health facility [49]
5.	Poor attitude [80]
6.	Age of newborn [45,51,73,81-83,88,96,99]
<b>Level 2 (Model 2): Proximal intermediate factors</b>	
1.	Place of delivery [48,73,82,85,87,92,95-98]
2.	Breast feeding practice (TIBF) [47,83,84,89,90,97,98]
3.	Intention/plan to breastfeed [82]
4.	Mode of delivery [50,75,82,96]
5.	Breast complication [96]
6.	Breastfeeding self-efficacy [54]
7.	Breastfeeding outcome expectancy [54]
8.	Sex of new born [100]
<b>Level 3 (Model 3): Distal intermediate factors</b>	
1.	Antenatal visit [47,48,65,90-92,98]
2.	Postnatal visit [90-92,99,100]
3.	Prelacteal feeding [47,86,88,92]
4.	Colostrum feeding [63,73,88,93,98]
<b>Level 4 (Model 4): Distal factors</b>	
1.	Paternal educational status [47,84,87,90,100]
2.	Household income [45,47,75,88,90,92,95]
3.	Marital status [45,49,91,96]
4.	Parity [50,100]
5.	Husband support [88,97]
6.	Maternal age [50,87,89,92,97,99]
7.	Place of residence [47,50,87,89]
8.	Family size [100]

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778 **Table 5: Characteristics of included studies that reported the prevalence and/or least adjusted associated factors of TICE.**

First author and year of publication	Region	Place	Study area	Study design	Study population	Sample size/Participated	Data collection technique	Prevalence	Associated factors (least adjusted)
Ayana et al 2017[101]	Benishangul Gumuz, Northwest Ethiopia	Urban and rural	Pawe District	Cross-sectional study	Mothers with children 6–23 months	806/785	Interviewer-administered	61.8%	Urban residence Postnatal care
Demilew et al 2017[102]	Amhara, Northwest Ethiopia	Urban	Bahir Dar City	Cross-sectional study	Mothers with children 6 and 23 months	423/412	Interviewer-administered ( 24-hr recall method)	7% <sup>¥</sup>	High maternal educational status Postnatal care Access to mass media Health institution delivery
Kassa et al 2016[103]	Oromia, Southeastern Ethiopia	Rural	Arsi Negele Woreda	Cross-sectional study	Mothers with children 6–23 months	626/611	Interviewer-administered	9.5% <sup>¥</sup>	Child's age (12–17 months) Maternal educational status (primary) Small family size
Semahegn et al 2013[52]	Harari, Eastern Ethiopia	Urban	Harar town	Cross-sectional study	Mothers with children 6–23 months	203/200	Interviewer-administered	60.5%	Sex of child
Shumey et al 2013[53]	Tigray, Northern Ethiopia	Urban	Mekele town	Cross-sectional study	Mothers with children 6 to 12 months	422/422	Interviewer-administered	62.8%	High maternal educational status Housewife Parity Antenatal care Birth preparedness
Sisay et al 2016[104]	Amhara, Northeast Ethiopia	Urban and rural	Lalibela District	Cross-sectional study	Mothers with children 6–23 months	421/421	Interviewer-administered	63 %.	Maternal educational status Antenatal care Health institution delivery
Zelege et al 2017[105]	Amhara, Northwest Ethiopia	Urban	Feres Bet Town	Cross-sectional study	Mothers with children 6 to 23 months	353/351	Interviewer-administered	23.9% <sup>¥</sup>	Child age (>9 months) Husband's occupation (employed) Maternal weaning advice Family size (larger >=4)
Mekbib et al 2014[106]	Tigray, Northern Ethiopia	Urban	Abyi-Adi town	Cross-sectional study	Mothers with children 6 - 23 months	434/428	Interviewer-administered	10.75% <sup>¥</sup>	Child's age High maternal educational status Postnatal care
Gessese et al 2013[107]	Amhara, Northwest	Urban and	Enemay district	Cross-sectional	Mothers with children 6-23	554/543	Interviewer-administered	40.5% <sup>¥</sup>	Child age (higher) Higher family income

	Ethiopia	rural		study	months				Antenatal care Health institution delivery
Yemane et al 2014[108]	Tigray, Northern Ethiopia	Urban	Axum town	Cross- sectional study	Mothers with children 6 to 24 months	422/422	Interviewer- administered	52.8%	Antenatal care Home delivery
Molla et al 2017[109]	Amhara, Northeast Ethiopia	Rural	Lasta District	Cross- sectional study	Mothers with children 6-23 months	476/470	Interviewer- administered	56.5%	Exposure to public media Occupation of mother (housewife) Maternal decision making Postnatal care
Regassa 2014[69]	SNNPR, Southern Ethiopia	Urban and rural	Sidama zone	Cross- sectional study	Mothers with infants < 6 months	1,100/1,094	Interviewer administered	71.5%	---
Agedew et al 2014[110]	SNNPR, Southern Ethiopia	Urban and rural	Kamba Woreda	Cross- sectional study	Mothers with children 6 to 24 months	567/562	Interviewer- administered	40.6%	---
Deme et al 2015[29]	Oromia, East Ethiopia	Urban	Bishoftu town	Cross- sectional study	Mothers with children < six months	422/422	Interviewer- administered	67.1%	Timely initiation of breastfeeding Housewife Home delivery Lack of knowledge on infant feeding
Disha et al 2012[43]	National	Urban and rural	National	Cross- sectional study (EDHS based)	Mothers with children 0-23 months	244/244	Interviewer administered	60.7%	---
Wubante 2017[55]	Amhara, Northwest Ethiopia	Urban and rural	Dabat District	Case-control study	Mothers with children < one year	400/400	Interviewer- administered	86.3%	---
Yonas et al 2015[72]	Oromia, Southwest Ethiopia	Mixed	Shashemene Woreda	Case-control study	Mothers with children < 24 months	423/417	Interviewer- administered	65.7%	---
Abera 2012[95]	Harari, Eastern Ethiopia	Urban	Harar town	Cross- sectional study	Mothers of children < two years	604/583	Interviewer- administered	54.4%	Monthly income Antenatal care
Yohannes et al 2018 [76]	SNNPR, Southwest Ethiopia	Rural	Soro district	Cross- sectional study	Mothers with children 6-23 months	543/543	Interviewer- administered	34.3%	High educational status Postnatal care
Ersino et al 2016a[79]	SNNPR, Southern Ethiopia	Rural	Halaba	Cross- sectional	Mothers with children < 2	31/31	Interviewer administered	58.1%	---

				study	years				
Ersino et al 2016b[79]	SNNPR, Southern Ethiopia	Rural	Zeway	Cross- sectional study	Mothers with children < 2 years	9/9	Interviewer administered	44.4%	---

779 EDHS = Ethiopian Demographic Health Survey; SNNPR = Southern Nations, Nationalities, and Peoples' Region; ¥ = Timely initiation, minimum meal frequency  
780 and minimum meal diversity



781 **Table 6: Predictors of complementary feeding and hierarchical theoretical model.**

S.No.	Factors
<b>Level 1 (Model 1): Proximal factors</b>	
1.	Mothers' occupational status [29,53,109]
2.	Mothers' decision making [109]
3.	Mothers' knowledge of complementary feeding [29,102,109]
4.	Guidance and counselling on complementary feeding [105]
5.	Age of newborn [103,105-107]
<b>Level 2 (Model 2): Proximal intermediate factors</b>	
1.	Place of delivery [29,102,104,107,108]
2.	Breastfeeding practice (TIBF) [29]
3.	Sex of newborn [52]
<b>Level 3 (Model 3): Distal intermediate factors</b>	
1.	Desire for pregnancy/plan for pregnancy [53]
2.	Antenatal visit [53,95,104,107,108]
3.	Postnatal visit [76,101,102,106,109]
<b>Level 4 (Model 4): Distal factors</b>	
1.	Paternal educational status [53,76,102-104,106]
2.	Household income [95,107]
3.	Husband occupation [105]
4.	Family size [103,105]
5.	Parity [53]
6.	Place of residence [101]

792 **Table 7: Number of studies in each region/city and prevalence estimate (National, regional and areal) of infant and young child feeding indicators.**

Infant and Young Child Feeding indicators	Number of studies per region/city and total population			National prevalence (%)	Regional prevalence (%)		Areal prevalence(%)		
	Name of region/city	Number of studies	Population <sup>+</sup>		Amhara	Other regions	Rural	Urban	Rural and Urban
TIBF*	Addis Ababa	3	3,273,000	66.5 (95% CI 62.1 - 70.8)	68.2 (95% CI 59.9 - 76.0)	65.4 (95% CI 60.2 - 70.5)	62.3 (95% CI 52.9 - 71.3)	74.5 (95% CI 67.6 - 80.9)	60.7 (95% CI 55.2 - 66.1)
	Afar	3	1,723,000						
	Amhara	17	20,401,000						
	Benshangul-Gumaz	-	1,005,000						
	Dire Dawa	-	440,000						
	Gambela	-	409,000						
	Harari	1	232,000						
	Oromia	7	33,692,000						
	Somali	-	5,453,000						
	SNNP	9	5,056,000						
	Tigray	2	18,276,000						
EBF <sup>¥</sup>	Addis Ababa	2	3,273,000	60.1 (95% CI 55.5 - 64.6)	58.6 (95% CI 51.3 - 65.8)	61.0 (95% CI 54.8 - 67.0)	68.8 (95% CI 60.8 - 76.3)	54.9 (95% CI 47.5 - 62.3)	60.0 (95% CI 52.3 - 67.3)
	Afar	2	1,723,000						
	Amhara	17	20,401,000						
	Benshangul-Gumaz	-	1,005,000						
	Dire Dawa	-	440,000						
	Gambela	-	409,000						
	Harari	1	232,000						
	Oromia	5	33,692,000						

	Somali	-	5,453,000						
	SNNPR	12	5,056,000						
	Tigray	3	18,276,000						
TICF <sup>f</sup>	Addis Ababa	-	3,273,000	62.5 (95% CI 56.6 - 68.2)	67.8 (95% CI 57.2 - 77.6)	60.2 (95% CI 53.0 - 67.1)	54.8 (95% CI 36.5 - 72.5)	64.9 (95% CI 57.6 - 71.9)	63.8 (95% CI 54.3 - 72.8)
	Afar	-	1,723,000						
	Amhara	6	20,401,000						
	Benishangul- Gumuz	1	1,005,000						
	Dire Dawa	-	440,000						
	Gambela	-	409,000						
	Harari	2	232,000						
	Oromia	3	33,692,000						
	Somali	-	5,453,000						
	SNNPR	5	5,056,000						
	Tigray	3	18,276,000						

\*=Two national studies and one study conducted in SNNPR, Oromia and Amhara region; SNNPR = Southern Nations, Nationalities, and Peoples; <sup>y</sup>= Two national studies; <sup>f</sup>= One national study; +=2015 population projection (available at <http://www.citypopulation.de/Ethiopia.html> )

798     Supplementary file 1: Search string for all databases searched.

799     Supplementary file 2: Overview of studies excluded after full-text review.

800     Supplementary file 3: Meta-analyses results for various variables. This was prepared to maintain the conciseness of

801     the main manuscript.